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Cover photo: Typical full spanning log structure installed in the Upper Nestucca River during a 1987 Stream Rehabilitation Project.

Abstract

Two stream reaches in the upper Nestucca River drainage, Tillamook County, Oregon, were analyzed for three large woody debris loading levels that would result from different riparian management practices. Summer juvenile populations of coho salmon (*Oncorhynchus kisutch*), steelhead (*O. mykiss*), and cutthroat trout (*O. clarkii*) were estimated based on habitat changes resulting from different debris loads. The low level (0.7 pieces per 100 m of stream) assumed no large woody debris influenced instream habitat conditions, whereas the high level (11.0 pieces per 100 m of stream) was attained after artificially restructuring the channels with conifers taken mostly from the adjacent riparian zone. Catch estimates of mature salmon and trout were derived from summer juvenile populations and timber stumpage was based on values generated from the adjacent coniferous riparian stand. Pool habitat increased tenfold between low and high debris loading levels. Juvenile fish population increases, based on changes in habitat conditions from low to high debris levels, were an estimated 60 percent for steelhead, sixfold for coho salmon, and twelvefold for cutthroat. The value of conifers in riparian zones for anadromous fish was then compared to maximum timber production. The benefits of maintaining 2 km of stream at a high debris loading level were calculated to be 11 percent greater by year 20 and 59 percent higher after 94 years (an increase of over $100,000 in present value) over conifer stumpage in the riparian zone. Management scenarios for stream rehabilitation and rehabilitation with conifer removal showed greater short-term fishery benefits than leaving a stream under a low debris loading level. However, long-term economic benefits of these two management scenarios were substantially less than for those streams managed under continuous high debris loading.

I. Introduction

The value of large woody debris (LWO) as fish habitat has been increasingly recognized, since large wood as instream structure represents a multifunctional value through pool formation, added cover, and stabilization of spawning gravel (Bisson et al 1987, Sedell et al 1988). Presently, some federal and state management guidelines for forested streams require buffers to protect water quality standards, with varying provisions for maintaining adequate numbers of mature conifers for potential LWD. In recent years, the size, amount, and species of trees needed in riparian zones along coastal Pacific Northwest streams supporting anadromous salmonids has been a concern.

In the past, the value of stream buffers was attributed to their ability to regulate water temperature, sedimentation, logging slash, and water quality (Brazier and Brown 1973, Froehlich 1973, Ponce 1974, Ringler and Hall 1975, Lynch, Corbett and Hoppes 1977). Because of the potential for catastrophic blowdown of stream buffers, the resulting excessive amounts of LWD were once concluded to be detrimental to fish habitat (Dykstra and Froehlich 1976).

Timber benefits and harvesting costs are relatively easy to determine (Andrus and Froehlich 1988), however, it is much more difficult to determine the economic benefits of timber in relation to its value as habitat for fish production. Fishery values are indirect, difficult to quantify, and occur over long periods. This is also true for conifers in streams, which have long residence times as LWD (Swanson and Lienkaemper 1978).

Early evaluations used estimated number of spawners and available spawning gravel per length of stream, estimates of fishery net economic values, and differential logging costs to determine the value of stream buffers (Sadler 1970, Gillick and Scott 1975, Dykstra and Froehlich 1976, Kunkel and Janik 1976). Sadler was the first to show that stream buffers have significant fishery values. Sadler's analysis showed that anadromous fish values offset timber values in these buffers. However, the results of these valuation methods did not consider for site-specific differences in stream habitat conditions.

To arrive at a more accurate estimate of fishery values for stream buffers, LWD loading was related to actual habitat conditions and then values based on the capability of these conditions to produce salmonids were projected. Fishery values were then assessed under four scenarios to arrive at net present values (NPV) and benefit-cost ratios; debris loading, conifer removal, rehabilitation, and conifer removal with rehabilitation.

II. Study Area

The upper Nestucca River Basin (51.3 km^2), with its major tributary system Elk Creek (26.6 km^2), is located in Tillamook County, Oregon. Riparian vegetation in the study area consists mainly of 70- to 100-year-old stands of Douglas-fir (*Psuedotsuga menziesii*) with understories of red alder (*Alnus rubra*), Douglas-fir, bigleaf maple (*Acer macrophyllum*), western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*). Streams in the study area run through mature conifer riparian zones. Events prior to the 1980s, including fire, floods, dam failure, roads, and stream cleaning activities eliminated most LWD from the stream channel. Two reaches in the Upper Nestucca River Basin were treated in 1987 with additions of LWD: the Nestucca River, included a 986-meter treated reach within a 12-km stream section; and Elk Creek, included a 975-meter reach within a 4.5-km section of stream.

Both study stream reaches support populations of chinook salmon (*Oncorhynchus tschawytscha*), coho salmon, summer and winter steelhead, and resident and sea-run cutthroat trout.

III. Methods

A. Habitat

Habitat was described following definitions of Bisson et al (1982), which divides the channel into pool types, riffles, and glides. The two study reaches were initially surveyed pretreatment in the summers of 1984 (Nestucca River) and 1985 (Elk Creek) and posttreatment in the summer of 1988. Pre and posttreatment surveys were conducted during similar flow conditions. Stream surveys were conducted to assess habitat conditions before and after introduction of LWD. The survey method provided measurements of habitat types, including the length, average width, and LWD for each habitat unit. Length and widths were measured with a hand tape to the nearest 30 cm using a hip chain. Large woody debris (greater than 15 cm in diameter and 3 m in length) was measured to determine average diameter (nearest 3 cm) and length (nearest 30 cm). To arrive at habitat conditions under the low debris loading level, pool habitat created by LWD (identified in the pretreatment survey) was converted into low gradient riffle habitat. It was assumed that riffle rather than pool habitat would have occurred in areas without the presence of LWD.

B. Large woody debris

Three levels of debris loading used in the analyses were based on pre and posttreatment habitat surveys (Table 1). Since study streams flow through mature conifer riparian zones which provide a continual sporadic input of LWD, the low debris loading level was determined by subtracting all LWD identified in the pretreatment survey creating pool habitat. The low range of debris loading was assumed to resemble conditions found in streams where the riparian zone provided no LWD input. The midrange debris loading was derived from the pretreatment survey. The highest range of debris loading, taken from the posttreatment survey included the addition of 27 full spanning, 53 partial spanning, and 39 cover structures constructed from 99 mature conifers (most over 30 meters in length). The mature conifers came from three sources: (1) 75 from adjacent upslope and riparian area, (2) three from downed trees in a high flow channel, and (3) 21 conifers needed to replace boulder material used in the construction of six full spanning structures on Elk Creek. The addition of this material was assumed to simulate channel conditions under a natural debris loading level. Conifers were felled, yarded, and bucked and then secured in the active channel. To simulate larger diameter debris input, all full spanning structures were constructed of two or three logs placed either triangularly or side-by-side. All log structures were secured by pinning with rebar and/or cabling to available anchoring material and entrenching one or both ends into the bank.

Table 1. The amount, size, and type of large woody debris in 1,961 meters of the main channels in the Nestucca River and Elk Creek

	Debris loading			
Woody debris	**Controls**[a]	**Low**[b]	**Medium**	**High**
Number of pieces				
Within high flow channel	—	14	55	216
Full spanning	—	0	2	30
Partial spanning	—	0	21	56
Pieces per 100 m	18.9	0.7	2.8	11.0
Pieces per 100 m influencing habitat conditions	—	0.0	1.2	4.4
Average diameter (cm)	71	50	50	60
Total length (m) per 100 m	56.8	70	243	2,096
Average length (m)	3.1	5.0	4.4	9.7

[a]- Results from inventoring 72.1 km on five streams located on BLM land within the Nestucca River drainage, 1984-1987.
[b]- Eliminates LWD that created pool habitat in the pretreatment survey.

C. Fish populations

Because sampling of juvenile coho salmon in Elk Creek occurred during low escapements (Salem District, Bureau of Land Management (BLM), unpublished data, Salem, Oregon) and were not reflective of changing habitat conditions, two methods were used to estimate summer juvenile populations. In Elk Creek, coho juvenile density estimates by habitat type were used to calculate summer populations following the methodology of Reeves et. at. (1989). Whereas, density estimates in different habitat types derived by averaging data collected in 1980, 1985, 1986 and 1987 by BLM (unpublished data, Salem, Oregon) and by the Oregon Department of Fish and Wildlife (ODFW, unpublished data, research laboratory, Corvallis, Oregon) were used to calculate steelhead and cutthroat summer parr populations in both streams and coho juveniles in the Nestucca River. The juvenile densities within different habitat types were determined by electroshocking, seining, and/or visual observations and then multiplied by total area estimates for each habitat type to obtain the summer populations for the entire stream reach studied.

IV. Economic Evaluations

A. Riparian zone timber

The value of conifers in the adjacent riparian zone was taken from Andrus and Froehlich (1987), a riparian zone vegetation study conducted in the central Coast Range of Oregon. To arrive at the closest values of riparian zone vegetation along the upper Nestucca River and Elk Creek, the stand characteristics of the 94-year riparian zone were used to calculate stumpage of the streamside conifers.

The riparian zone was 40 meters in width (both sides) and had stem densities of 45 and 6 trees (greater than 27 cm in diameter) per acre, respectively, for Douglas fir and hemlock. The volume per acre was 159 cubic meters of Douglas fir (averaging 56 cm in diameter at breast height) and 6 cubic meters of hemlock (averaging 33 cm in diameter at breast height). The stumpage value (net volume times mill price minus logging cost) was determined using a mill price of $58 per cubic meter for Douglas fir and $35 per cubic meter for hemlock with a logging cost of $21 per cubic meter.

B. Debris addition

At a contract cost (including equipment and labor) of $46,200, approximately 2 km of the upper Nestucca River and Elk Creek were treated with 119 log structures using 99 mature conifers. To account for the value of the wood structures in the analysis of the conifer removal with rehabilitation scenario, $9,900 ($100 per tree) was subtracted from the amount of timber sold.

C. Fish populations

The number of adult coho salmon, steelhead, and cutthroat trout were estimated from summer juvenile populations supported under different habitat conditions (Table 2). Survival estimates from summer juveniles to smolts and smolts to adults were used to calculate adults produced (ODFW Research station, unpublished data, Corvallis, Oregon). However, for coho salmon survival from summer juvenile to smolt, we used Reeves et al (1989). Sport and commercial catches were projected using rates supplied by ODFW (ODFW, unpublished data, Portland, Oregon).

The value of the fishery (total catch to annual commercial and sport values) was determined following procedures outlined by Kunkel and Janik (1976). To provide a more current valuation for coho salmon, the exvessel price paid per pound to commercial fishermen ($1.74/lb), dressed weight of commercially caught fish (6.3 lb/fish), harvest rates and activity days per fish for different sport fisheries by species, and value per activity day for each species (see listing in Table 3) were supplied by ODFW (ODFW, unpublished data, Portland, Oregon).

D. Value analyses

The fisheries values are based on exvessel prices for the commercial catch and travel cost model estimates of net willingness to pay for the sport catch. Analyses based on these values are estimates of the value to society of management options. Since willingness to pay values are not expenditures, the value estimates should not be interpreted as estimates of the effect on local business sales. The dollar value of benefits and costs were estimated for each year and discounted to yield estimates of net present value. The discounted, or present, values were then summed, and the discounted costs subtracted from the discounted benefits yielding the estimated net present value for each scenario. A discount rate of four percent was used for all scenarios. In addition, net present value was computed for time periods ending at 20-, 50-, and 94-year intervals, with 20 years representing the estimated longevity of rehabilitation structures, and 94 years corresponding to the riparian stand age used by Andrus and Froehlich (1987) and the approximate age of the existing riparian zone vegetation.

Four different scenarios were analyzed for NPV:

1. **Channel wood**– Net present values were determined from benefits derived from habitat conditions under low, medium, and high debris loading levels.

2. **Conifer removal**– This analysis assumed conifers were harvested in year one and stream values were generated from habitat conditions under low debris loading. This analysis also assumed the riparian zone

Table 2. Habitat changes and predicted salmonid production in 1,961 meters of the upper Nestucca River and Elk Creek under varying amounts of debris loading

	Large woody debris (#/100 m)		
Variables	**0.7**	**2.8**	**11.0**
Habitat amounts (m^2)			
Pools	1,694	3,059	16,366
Glide	2,863	2,936	893
Riffles			
High gradient	1,289	1,289	890
Low gradient	8,073	6,282	3,768
Secondary channel	337	693	845
Total	**14,256**	**14,256**	**22,762**
Summer juveniles[a]			
Coho	3,490	5,587	20,514
Steelhead (1+)	843	843	1,351
Cutthroat (1+)	20	46	249
Smolts[b]			
Coho	1,554	2,488	9,133
Steelhead	421	421	676
Cutthroat	10	23	125
Adults[c]			
Coho	116	187	685
Steelhead	43	43	68
Cutthroat	1	2	13

[a]Summer juvenile populations were estimated using the following densities in these habitat types:

	Nestucca River (#/m^2)	Elk Creek (#/m^2)
Coho Fry		
Pools and secondary channel riffles	1.0	1.5
Glides	0.2	0.8
High gradient riffles	0.05	0.4
Steelhead parr (all habitat types)	0.04	0.10
Cutthroat parr (pools only)	0.04	0.002

[b]Smolt numbers were determined using the following survival rates:

Coho salmon (Reeves et al. 1989) -	June to September	0.84
	September to March	0.53
Steelhead and cutthroat parr -	Midsummer to March	0.50

[c]Smolt to adult survival rates:	Coho Salmon	0.075
	Steelhead and cutthroat	0.10

would not provide woody debris sufficient in size to influence habitat conditions in the channel over the 94-year period.

3. Rehabilitation– This analysis assumed salmonid values were at pre-project debris loading levels for the first 3 years (benefits start at first harvest year), increased to the highest level through the 20th year, and reverted to pre-project midlevel values up to the 94th year. After 20 years, it is assumed most treatment structures will fail or fill, reducing pool habitat and salmonid production.

4. Conifer removal with rehabilitation– This analysis assumed conifers were harvested in year one and streams values were generated from habitat conditions under low debris loading except for years 4 through 20, where rehabilitation improved habitat conditions to support the highest fishery values.

V. Results

A. Debris loading

The size (average length and diameter), amount (total length and number), and density of LWD increased substantially from minimum debris loading to posttreatment conditions (Table 1). After treatment, the total number of pieces within the main channel increased fourfold over pretreatment and fifteenfold over minimum debris-loading levels. Large woody debris influencing the channel (partial and full spanning) also increased fourfold between pre and post-treatment levels. In the minimum debris-loading condition, no LWD influenced habitat conditions within the main channel.

B. Habitat

The amount and types of habitats changed substantially with varying debris-loading levels (Table 2). The total low flow wetted perimeter remained unchanged in the low debris and mid-debris levels, but increased by 60 percent in the highest debris loading level. Pool habitat showed the greatest change, doubling between the low and mid-debris levels and increasing tenfold between the low and high-debris levels. As LWD interacted with the channel, riffle and glide habitat was reduced and pool habitat increased.

C. Fish populations

A substantial change was predicted in salmonid populations under different debris loading conditions. The estimated number of summer juveniles, smolts, and adults increased as debris loading increased (Table 2). This increase was caused by the substantial increase in pools and secondary channels, the preferred habitat of young salmonids. Coho salmon juveniles, smolts, and adults increased about 60 percent from low to the midlevel and sixfold from the low to the high debris loading level. Steelhead juveniles, smolts, and adults increased about 60 percent from the low to the high debris loading level, while cutthroat trout doubled and increased twelvefold, respectively, from the low to the mid and low to high ranges of debris loading.

D. Salmonid catch and values

The following example shows how the increase in annual net economic value of the steelhead produced in Elk Creek resulting from the change in habitat conditions between low and high debris loading levels was calculated:

3,774 m^2	Increase in habitat
x 0.1	(steelhead juveniles/m^2)
377	Summer juveniles
x 0.5	(juvenile to smolt survival)
189	Steelhead smolts
x 0.1	(smolt to adult survival)
19	Steelhead adults
x 0.4	(catch rate)
8	Steelhead caught
x 4.0	(angler-days/fish)
32	Angler-days
x $25.86	(value/angler-day)
$828	Value of steelhead fishery

The estimated salmonid catch as well as number of adults ranged from no increase to 13 times over the range of debris loading levels depending on the fish species (Table 3). Steelhead show no increase between the low and midlevel debris loads, while a thirteenfold in increase in cutthroat trout occurred between low and high debris loads. The estimated annual value of the salmonid fishery generated from the catch increased 28 percent from the low to the midlevel and about fourfold from the low to the high debris loading level range ($3,191 to $11,382). Coho salmon accounted for approximately 50 percent of the total value in the low and mid debris-loading levels and increased to about 75 percent of the total value in the high debris loading level.

E. Value analysis

The fishery NPV of a stream under varying debris loading levels changed substantially from 20 through 94 years (Table 4). At the end of 94 years, the NPV of 2 km of stream increased 257 percent from $77,776 for the low debris loading level to $277,421 for the high debris loading level. When weighing the stumpage foregone against the NPV of the fishery produced under varying debris loads, the fishery benefits of maintaining a stream at a high debris loading level were 11 percent greater by year 20 and 59 percent higher after 94 years (an increase of $103,442) over conifer stumpage in the riparian zone.

Table 3. Estimated catch and annual net value of the anadromous fishery generated by 1,961 meters of upper Nestucca River and Elk Creek under varying amounts of debris loading.

	Large woody debris (#/100 m)		
Variables	0.7	2.8	11.0
Catch (numbers)[a]			
Coho	80.0	129.0	473.0
Steelhead	17.0	17.0	28.0
Cutthroat	0.2	0.4	2.7
Fish values ($)[b]			
Coho			
Commercial	614	986	3,628
Sport	816	1,322	4,826
Steelhead	1,759	1,759	2,897
Cutthroat	2	4	31
Total	**3,191**	**4,071**	**11,382**

[a]**Catch was estimated at:** Coho salmon - Commercial 48%
Ocean sport 18%
Inland sport 3%
Steelhead 40%
Cutthroat 20%

[b]**Sport fish values were determined using:**

	Angler-days/fish	Value/angler-day
Coho		
Ocean sport	0.8	40.28
Inland sport	3.3	13.06
Steelhead	4.0	25.86
Cutthroat	0.9	13.06

When comparing the NPVs of the fishery due to rehabilitation for all years, the benefits were about double the fishery values generated under low debris loading levels (Table 4). However, the fishery benefits of rehabilitation were substantially less than those in a stream managed for continuous high debris loading.

The management scenario of removing conifers from the riparian zone and then rehabilitating the stream produced a NPV gain of $19,530 for the first 20 years, but a loss of $45,112 and $68,796, respectively, in 50 and 94 years, compared to maintaining the stream at high debris loading levels.

Since angler-day values are variable, the fishery was also analyzed using values that were 25 percent lower than those listed in Table 3. Under this assumption, when comparing conifer removal to the high debris loading scenario, the NPV of maintaining a stream at high debris loading ($208,066) was still greater than conifer removal ($158,902).

Both stumpage and fishery values can fluctuate significantly depending on supply and demand, and benefits shown in these analyses would vary according to changes in the respective value of either resource.

VI. Discussion

The amounts and sizes of conifers in coastal riparian zones will ultimately determine large debris loading levels, which directly influence instream habitat conditions. In mature coastal riparian zones (94+ years), Andrus and

Table 4. The costs, annual benefits, and net present values (for 20,50 and 94 years) under different debris loads or management schemes for 2 km of the upper Nestucca River and Elk Creek.

Scenarios	Timber Harvest ($)	Project Cost ($)	Debris loading (#/100 m) 0.7 ($)	2.8 ($)	11.0 ($)
Channel wood		—			
Annual benefits ($)			3,191	4,071	11,382
Net present values ($)					
20 years			43,367	55,326	154,685
50 years			68,550	87,454	244,510
94 years			77,776	99,225	277,421
Conifer removal[a]	100,051				
Annual benefits ($)			3,191	—	—
Net present values ($)					
20 years			139,570	—	—
50 years			164,753	—	—
94 years			173,979	—	—
Rehabilitation[b]		46,200			
Annual benefits ($)			4,071 to 11,382		
Net present values ($)					
20 years			—	—	89,973
50 years			—	122,101	—
94 years			—	133,872	—
Conifer removal with rehabilitation[c]	90,151	46,200			
Annual benefits ($)			3,191 to 11,382		
Net present values ($)					
20 years			—	—	174,215
50 years			199,398	—	—
94 years			208,625	—	—

[a]Conifer values for 7.8 hectares of a 94-year riparian zone (Androus and Forehlich 1987)

[b]Contract costs (log material not included) and annual benefits under the following assumptions:

0-3 years	$4,071
4-20 years	$11,382
21-94 years	$3,191

[c]Net conifer values (including log material used for structures) and annual benefits under the following assumptions:

0-3 years	$3,191
4-20 years	$11,382
21-94 years	$3,191

Froehlich (1987) found an average of 12.6 conifers per hectare over 33 cm in diameter. This is similar to the 11.7 conifers per hectare over 25 cm in diameter counted along 4,536 meters of coastal riparian zones withdrawn from timber sales (Salem District, BLM, unpublished data, Oregon). However, as age of riparian stands increases the density of mature conifers decreases. Riparian stands 120 years and older supported only 9.7 conifers (64 cm and greater in diameter) per hectare (Andrus and Froehlich 1987). Data from BLM's counts revealed a density of only 7.0 conifers per hectare (50 cm and greater in diameter) in riparian areas running through mature conifer forests.

In the process of rehabilitating the study streams, 4.5 conifers (averaging 56 cm in diameter) per hectare were required to restructure the channels or about half the conifers found in older riparian zone stands. Because LWD becomes more stable as its length and diameter increase (Sedell et al 1988), only older, mature conifer riparian zones are capable of providing this type of structural input. Most importantly, the supply of large, mature conifers in riparian zones is limited, making protection and management for older LWD extremely important.

The 4.5 conifers per hectare in the riparian zone, when used as LWD in rehabilitation, represented a debris loading level of 11 pieces per 100 meters of stream. This is thought to represent a minimum level needed to achieve habitat conditions favorable for high salmonid production in coastal Oregon streams. Rehabilitation structures were initially secured and placed in hydrologically stable positions and areas, which probably does not occur in natural conditions. In undisturbed streams Sedell et al (1988) found 20 to 50 pieces per 100 meters of stream, or two to five times the amounts at the high debris loading level for this study. However, habitat conditions in undisturbed streams and the high debris loading level were probably similar. Pool habitat increases with increasing amounts of LWD (Sedell et al 1988), which accounts for pools amounting to only 12 percent of the available habitat at the low compared to 72 percent at the high debris loading level.

Presently, most coastal Oregon streams run through young riparian zone stands dominated by red alder. An analysis on 72.1 km of disturbed streams on BLM land within the Nestucca River drainage revealed debris loading levels of 18.9 pieces per 100 meters (averaging 71 cm in diameter), with an average length of 3.1 m and a total length of 56.8 m per 100 meters of stream (Table 1). This relatively large diameter (71 cm) probably reflects debris left from logging old growth stands. For these streams in the Nestucca drainage, the density and average diameter of LWD pieces, respectively, were greater than those found in our study's high and mid-debris loading levels. However, the average length per LWD piece in these streams was considerably shorter than those found in the low debris loading level. The relatively low amounts of LWD in Nestucca basin streams coincides with Heimann's (1988) prediction, where he theorized that trends in debris volume in small coastal streams would steadily decline if managed under a 80-year riparian rotation. Because of the short length of these pieces, their stability and capability to influence instream habitat conditions is limited. If the resulting conditions correspond to those found under the low debris loading level, coastal Oregon streams would be producing far below their potential as shown at the high debris loading level with coho salmon, steelhead, and cutthroat trout producing at only 17, 63, and 8 percent of their estimated capability, respectively.

Reduced productivity observed in study streams is believed to be generally representative of current conditions in 7,680 km of coastal Oregon streams used by coho salmon (ODFW 1985). Corresponding low levels of fish production would result in an annual loss of millions of dollars to Oregon's economy due to reduced catches in sport and commercial fisheries.

Our analysis showed that by the 20th year, the benefits of maintaining these streams at a high debris loading level outweigh the costs of the conifer stumpage in the riparian zone. After 94 years, the removal of conifers in the riparian zone results in a net loss of over $100,000 for 2 km of stream retained at a low debris loading level. This potentially represents a long-term economic loss for anadromous fish production.

When analyzing stream rehabilitation without conifer values, the NPV increased $34,647 over 20 and 94 years after rehabilitation for a 1.7:1 benefit-cost ratio. However, the NPV of stream rehabilitation is substantially lower than those generated by streams managed for high debris loading levels. Also, stream rehabilitation should be considered a short-term-measure, treating only key areas of high value, presently degraded systems that have no chance of natural restructuring over a long time period. Most rehabilitation projects, because of their fixed nature, cannot be expected to function effectively over long time periods because structures can fill with bedload (decreasing pool habitat) and eventually fail physically.

Another scenario analyzed was combining conifer removal with stream rehabilitation. In this scenario, costs would not be as high as confier removal or rehabilitation so NPVs would be higher than for both other scenarios. However, this scenario would prohibit future input of LWD resulting in a short-term increase in NPV for 20 years ($19,530) but a subsequent NPV loss of $45,112 after 50 years when compared to a stream running through a mature conifer riparian zone producing high debris loads.

Based on our analyses, the best economic alternative to protect and maintain salmonid productivity of our coastal Oregon streams is through maintenance of mature coniferous riparian zones. Stream rehabilitation and other artificial attempts to increase anadromous salmonid production are more expensive than maintaining healthy, sustaining riparian zones, capable of supplying a continuous input of mature conifers to the channel. Riparian zones must be wide enough and sufficiently stocked with conifers to produce those instream habitat conditions needed for high production of salmon and trout.

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